

Appendix

Differential gas exchange and soil microclimate dynamics under biodegradable plastic, polyethylene, and paper mulches

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**Supporting information includes tables on gas diffusion coefficients and gas
concentrations and diffusive fluxes.**

Table S1: Comparison of CO₂ and H₂O diffusion coefficients of the soil at Day 0 derived with different methods.

Method	CO ₂ diffusion coefficient (cm ² s ⁻¹)	H ₂ O diffusion coefficient (cm ² s ⁻¹)
Ficks Law	1.45 × 10 ⁻²	8.15 × 10 ⁻²
(Penman, 1940)	4.74 × 10 ⁻²	7.88 × 10 ⁻²
(Marshall, 1959)	8.68 × 10 ⁻²	14.1 × 10 ⁻²
(Millington and Quirk, 1960)	4.61 × 10 ⁻²	7.48 × 10 ⁻²
(Moldrup et al., 1996)	4.00 × 10 ⁻²	6.49 × 10 ⁻²
(Moldrup et al., 1997)	2.67 × 10 ⁻²	4.34 × 10 ⁻²

The equations were obtained from (Jury and Horton, 2004; Marshall, 1959; Millington and Quirk, 1960; Moldrup et al., 1997, 1996; Penman, 1940).

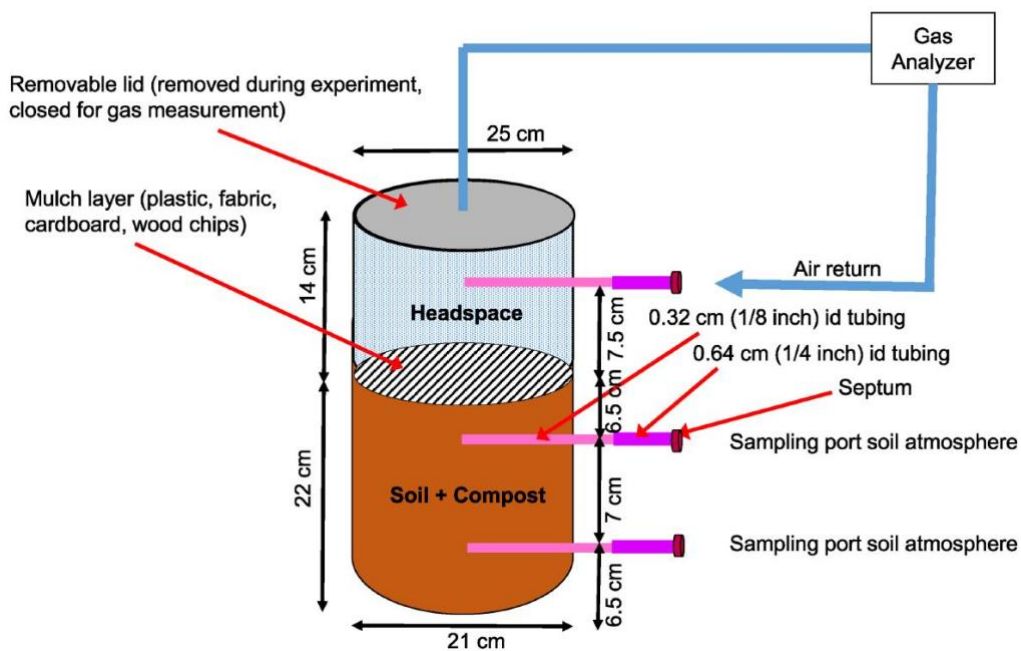


Fig. S1. Schematic of the mesocosm used for the in vitro gas exchange and soil microclimate Experiment. (Source of schematic: Shahzad et al. 2019).

Table S2. Mulch effects on soil CO₂ concentration in the greenhouse before planting sweet corn.

Mulch	Day 0	Day 1	Day 2	Day 5	Day 10	Day15	Day20
-----CO ₂ concentration in top port (mmol mol ⁻¹)-----							
No-mulch	2.18±0.13a	1.75±0.07a	1.21±0.13a	0.97±0.11a	0.87±0.11a	0.96±0.08a	1.02±0.10a
No-mulch (no-plant)	2.15±0.49a	1.80±0.38a	1.20±0.13a	1.07±0.3a	0.92±0.09a	1.02±0.05a	1.00±0.08a
Organix	9.06±0.36c	13.18±2.51c	12.9±1.77d	10.6±1.16b	8.22±0.35b	5.99±1.09b	5.34±0.81b
Organix (hole)	4.90±0.90b	3.93±0.73b	3.36±0.23c	2.29±0.71a	1.94±0.24a	2.09±0.27a	2.29±0.44a
Paper	2.01±0.24a	1.82±0.28a	1.18±0.11a	0.92±0.34a	0.88±0.08a	0.96±0.12a	0.97±0.08a
Paper (hole)	2.06±0.23a	1.80±0.26a	1.44±0.38ab	1.03±0.15a	0.94±0.1a	1.07±0.08a	1.10±0.14a
Polyethylene	8.70±1.24c	13.6±2.37c	13.0±1.41d	11.9±1.39b	9.74±0.78b	10.0±0.46c	9.10±1.99c
Polyethylene (hole)	5.10±0.63b	3.69±0.18b	3.12±0.79bc	1.97±0.17a	1.91±0.47a	2.12±0.42a	2.30±0.27a
-----CO ₂ concentration in bottom port (mmol mol ⁻¹)-----							
No-mulch	2.69±0.21a	2.21±0.18a	1.59±0.32ab	1.12±0.09a	1.05±0.11a	1.21±0.1a	1.13±0.10a
No-mulch (no-plant)	2.80±0.4a	2.15±0.21a	1.55±0.27a	1.19±0.18a	1.03±0.04a	1.16±0.09a	1.09±0.13a
Organix	9.85±0.29c	14.2±3.25c	14.0±2.09d	11.0±1.36b	8.30±0.35b	6.19±0.82b	5.51±0.69b
Organix (hole)	5.71±0.8b	4.55±0.83b	3.54±0.63c	2.28±0.65a	2.13±0.23a	2.28±0.09a	2.23±0.49a
Paper	2.63±0.3a	2.36±0.21a	1.55±0.04a	1.12±0.29a	1.06±0.07a	1.11±0.12a	1.17±0.18a
Paper (hole)	2.53±0.24a	2.18±0.21a	1.66±0.35abc	1.22±0.29a	1.13±0.04a	1.19±0.14a	1.16±0.14a
Polyethylene	10.3±1.65c	15.2±1.97c	14.9±0.64d	12.3±1b	10.3±1.43c	10.9±0.65c	10.41±2.08c
Polyethylene (hole)	5.77±0.29b	4.37±0.35b	3.51±0.62bc	2.41±0.23a	2.14±0.45a	2.35±0.31a	2.65±0.36a

Within measurement time, means not sharing any letter are significantly different using the least squares means and adjusted Tukey multiple comparison ($P < 0.05$). Values represent the mean \pm standard deviation ($n = 4$).

Table S3. Mulch effects on soil O₂ concentration in the greenhouse before planting sweet corn.

Mulch	Day 0	Day 1	Day 2	Day 5	Day 10	Day15	Day20
-----O ₂ concentration in top port (mmol mol ⁻¹)-----							
No-mulch	204±2.22d	205±1.29c	205±0.82b	208±2c	207±1.71b	209±0.00b	209±0.50b
No-mulch (no-plant)	203±1.71cd	204±2.22c	206±2.63b	208.25±0.96c	207±2.31b	209±0.50b	209±0.50b
Organix	190±6.29ab	184±7.04a	193±4.03a	199±2.06ab	201±1.50ab	204±0.96ab	204±0.82ab
Organix (hole)	199±2.38cd	200±2.06bc	203±1.29b	208±2.00c	204±0.50b	209±0.50b	209±0.50b
Paper	204±1.89d	205±1.91c	205±1.41b	208±0.96c	207±2.63b	209±0.00b	209±0.58b
Paper (hole)	204±1d	204±1.71c	205±2.63b	206±6.00bc	206±1.91b	209±0.50b	209±0.00b
Polyethylene	188±6.13a	183±7.41a	190±4.72a	195±3.30a	196±2.50a	199±1.71a	199±0.82a
Polyethylene (hole)	196±5.1bc	197±5.91b	204±3b	207±2.89c	205±2.50b	209±0.58b	209±1.00b
-----O ₂ concentration in bottom port (mmol mol ⁻¹)-----							
No-mulch	203±2.21d	204±0.96c	205±0.58b	207±2.06b	206±2.38b	208±1.50b	209±0.50b
No-mulch (no-plant)	202±1.70cd	203±2.5bc	206±2.22b	208±0.58b	207±2.63b	209±0.00b	209±0.50b
Organix	189±6.27ab	183±7.33a	193±2.08a	197±6.29a	201±1.29ab	203±1.50ab	204±1.00ab
Organix (hole)	198±2.95cd	199±3.3bc	203±1.26b	207±2.89b	204±0.96b	208±2.00b	207±1.71b
Paper	203±1.89d	204±1.50c	205±0.5b	208±1.91b	205±0.58b	209±0.50b	209±0.50b
Paper (hole)	203±1.03d	204±1.71c	205±2.63b	206±5.5b	205±0.96b	208±2.00b	209±0.58b
Polyethylene	187±6.02a	181±7.41a	188±3.2a	195±2.08a	195±2.16a	198±0.82a	198±0.82a
Polyethylene (hole)	196±5.19bc	196±6.48b	203±1.71b	206±2.22b	204±0.50b	209±0.50b	209±0.00b

Within measurement time, means not sharing any letter are significantly different using the least squares means and adjusted Tukey multiple comparison ($P < 0.05$). Values represent the mean ± standard deviation ($n = 4$).

Table S4. Mulch effects on soil CO₂ concentration in the greenhouse after planting sweet corn.

Mulch	Day 0	Day 1	Day 5	Day 15	Day 30
----- CO ₂ concentration in top port (mmol mol ⁻¹) -----					
No-mulch	1.02±0.10a	1.33±0.20a	1.24±0.23a	2.16±0.81a	1.88±0.38a
No-mulch (no-plant)	1.00±0.08a	1.33±0.17a	1.15±0.06a	2.16±0.32a	1.12±0.13a
Organix (hole)	2.29±0.44b	2.73±0.76c	2.5±0.48b	4.31±0.65b	3.76±0.59b
Paper (hole)	1.10±0.14a	1.35±0.12ab	1.33±0.05a	2.21±0.46a	1.95±0.34a
Polyethylene (hole)	2.3±0.27b	2.26±0.32bc	2.48±0.70b	4.79±0.63b	3.92±0.33b
----- CO ₂ concentration in bottom port (mmol mol ⁻¹) -----					
No-mulch	1.13±0.10a	1.45±0.38a	1.46±0.11ab	2.28±1.04a	2.06±0.37a
No-mulch (no-plant)	1.09±0.13a	1.37±0.13a	1.23±0.11a	2.05±0.45a	1.10±0.17a
Organix (hole)	2.23±0.49ab	2.93±1.14b	2.54±0.51b	4.33±0.73b	3.65±0.90b
Paper (hole)	1.16±0.14a	1.33±0.11a	1.39±0.23ab	2.19±0.46a	2.01±0.47a
Polyethylene (hole)	2.65±0.36b	2.73±0.59b	2.48±0.65b	5.43±0.83b	4.01±0.60b

Within measurement time, means not sharing any letter are significantly different using the least squares means and adjusted Tukey multiple comparison ($P < 0.05$). Values represent the mean ± standard deviation ($n = 4$).

Table S5. Mulch effects on soil O₂ concentration in the greenhouse after planting sweet corn.

Mulch	Day 0	Day 1	Day 5	Day 15	Day 30
----- O ₂ concentration in top port (mmol mol ⁻¹) -----					
No-mulch	208.8±0.50a	209.0±0.00a	209.0±0.00a	208.0±2.00ab	209.0±0.00a
No-mulch (no-plant)	208.8±0.50a	209.0±0.00a	209.0±0.00a	208.3±0.96b	208.8±0.50a
Organix (hole)	208.8±0.50a	208.3±0.50a	208.5±1.00a	206.5±1.29ab	207.8±1.26a
Paper (hole)	209.0±0.00a	209.0±0.00a	208.8±0.50a	208.0±0.82ab	209.0±0.00a
Polyethylene (hole)	208.5±1.00a	208.0±0.82a	209.0±0.00a	206.3±1.50a	207.3±0.96a
----- O ₂ concentration in bottom port (mmol mol ⁻¹) -----					
No-mulch	208.8±0.50b	209.0±0.00a	209.0±0.00a	206.5±1.73ab	208.8±0.50a
No-mulch (no-plant)	208.8±0.50b	209.0±0.00a	209.0±0.00a	207.8±1.26bc	209.0±0.00a
Organix (hole)	206.8±1.71a	208.0±0.82a	208.5±1.00a	206.0±1.15ab	207.5±0.58a
Paper (hole)	208.5±0.58ab	208.5±1.00a	208.5±0.58a	209.0±0.00c	208.8±0.50a
Polyethylene (hole)	209.0±0.00b	207.6±0.96a	209.0±0.00a	205.8±0.96a	207.3±0.96a

Within measurement time, means not sharing any letter are significantly different using the least squares means and adjusted Tukey multiple comparison ($P < 0.05$). Values represent the mean ± standard deviation ($n = 4$).

Table S6. Mulch effects on CO₂ and H₂O diffusive fluxes of the mulch treatments as a function of time in the greenhouse before planting sweet corn.

Mulch	Day 0	Day 1	Day 2	Day 5	Day 10	Day15	Day20
----- CO ₂ flux (g CO ₂ m ⁻² hr ⁻¹) -----							
No-mulch	0.25±0.04c	0.23±0.00b	0.17±0.01b	0.16±0.01b	0.16±0.01b	0.16±0.01b	0.16±0.01b
No-mulch (no-plant)	0.25±0.03c	0.23±0.02b	0.17±0.00b	0.16±0.01b	0.16±0.00b	0.17±0.00b	0.16±0.00b
Organix	0.06±0.02a	0.11±0.01a	0.11±0.02a	0.10±0.01a	0.10±0.01a	0.08±0.01a	0.08±0.01a
Organix (hole)	0.14±0.03b	0.12±0.02a	0.11±0.01a	0.08±0.01a	0.08±0.01a	0.08±0.01a	0.08±0.01a
Paper	0.26±0.03c	0.23±0.01b	0.17±0.02b	0.15±0.01b	0.16±0.01b	0.16±0.01b	0.16±0.01b
Paper (hole)	0.27±0.08c	0.23±0.01b	0.17±0.01b	0.16±0.01b	0.16±0.01b	0.16±0.01b	0.16±0.01b
Polyethylene	0.05±0.01a	0.11±0.03a	0.11±0.01a	0.10±0.01a	0.10±0.00a	0.10±0a	0.10±0.00a
Polyethylene (hole)	0.13±0.01b	0.12±0.01a	0.11±0.01a	0.08±0.01a	0.08±0.01a	0.08±0.01a	0.08±0.01a
----- H ₂ O flux (g H ₂ O m ⁻² hr ⁻¹) -----							
No-mulch	6.05±0.31d	3.51±0.17d	3.46±0.51d	1.97±0.13d	1.66±0.13c	1.22±0.08e	1.07±0.07c
No-mulch (no-plant)	5.92±0.43d	3.36±0.35d	3.16±0.56d	1.76±0.11d	1.51±0.13c	1.16±0.08de	1.04±0.08c
Organix	1.02±0.09bc	0.86±0.08bc	0.81±0.09bc	0.68±0.13bc	0.76±0.05b	0.59±0.07bc	0.57±0.08abc
Organix (hole)	1.48±0.23c	1.09±0.09c	1.08±0.11c	0.83±0.06c	0.81±0.05b	0.65±0.03bcd	0.63±0.02bc
Paper	5.71±0.9d	3.27±0.56d	3.16±0.49d	1.71±0.25d	1.47±0.13c	1.13±0.09cde	1.00±0.03c
Paper (hole)	5.83±0.32d	3.31±0.22d	3.21±0.53d	1.78±0.13d	1.47±0.09c	1.14±0.06de	0.99±0.06c
Polyethylene	0.07±0.01a	0.07±0.01a	0.07±0.01a	0.06±0.02a	0.06±0.02a	0.04±0.01a	0.03±0.01a
Polyethylene (hole)	0.56±0.05ab	0.42±0.03ab	0.34±0.12ab	0.25±0.04ab	0.30±0.07ab	0.19±0.05ab	0.17±0.04ab

Within measurement time, means not sharing any letter are significantly different using the least squares means and adjusted Tukey multiple comparison ($P < 0.05$). Values represent the mean \pm standard deviation ($n = 4$).

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